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A SIMULATED MISSION SUCCESS INDICATOR FOR USE WITH PROBABILITY --ETC(U)
APR 77   G E O'CONNOR, M J YOUNG

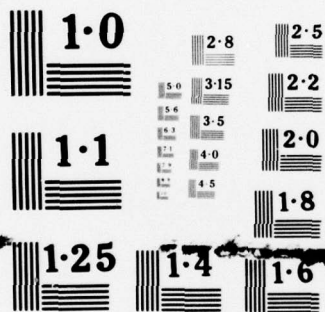UNCLASSIFIED   USAFETAC-8088B   NL

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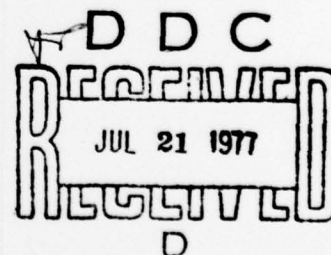SCOTT AIR FORCE BASE, ILLINOIS 62225

Report 8088B

A SIMULATED MISSION SUCCESS INDICATOR
FOR USE WITH PROBABILITY FORECASTS AT
TRAVIS AFB, CALIFORNIA

by

Gary E. O'Connor, Capt, USAF
and
Murray J. Young

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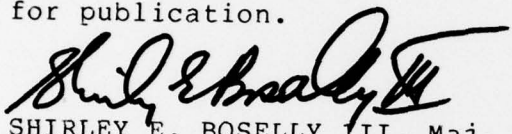RECEIVED
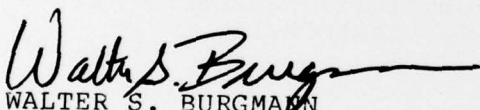JUL 21 1977
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FOR THE COMMANDER

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Using a simulated mission success indicator along with a probability forecast of cloud ceiling and visibility at a later time, one can base an operational decision on the chance for success. This report describes the use of this tool for Travis AFB, California.

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Preface

USAFETAC prepared this report to answer a request from 7th Weather Wing for forecasting assistance at Travis AFB, California. Headquarters 60th Military Airlift Wing (MAC) originated the request to Detachment 2, 7th Weather Wing stating the need for improved accuracy in the forecasting of the onset and dissipation of fog conditions in support of flying operations.

USAFETAC provided a tool in the form of Wind Direction/ Dew Point Stratified Conditional Climatology Tables for Travis AFB, California (USAFETAC Report 8088A) and planned to provide further assistance.

Subsequent discussion at Hq Air Weather Service and Hq 7th Weather Wing resulted in the conclusion that decision assistance with probability forecasts was the logical development program to follow. With this report, we are providing and describing the decision assistance tables in the form of Simulated Mission Success Indicators (SMSI).

If the requestor or any other agency incorporates this report into another report, we request that USAFETAC be given proper credit and furnished a copy of the new report in all cases where such dissemination is not prohibited.

This report was prepared to accompany a set of specific SMSI tables. It is the second and last step in this particular USAFETAC project to provide assistance to the forecaster and MAC operations personnel at Travis AFB. Questions related to this specific climatological problem should be referred to USAFETAC for consultation and study.

A SIMULATED MISSION SUCCESS INDICATOR
(SMSI) FOR USE WITH PROBABILITY FORECASTS
AT TRAVIS AFB, CALIFORNIA

Introduction

This report describes the use of SMSIs in conjunction
with probability forecasts. For illustrative purposes this
report uses the wind direction/dewpoint stratified condi-
tional climatology (CC) tables as described in USAFETAC
Report 8088A [1] as the probability forecast source. In
real time operations, most likely, the Air Force Global
Weather Central (AFGWC) or the station forecaster would
provide the probability forecast.

Operational Problem

Determining the onset, duration, and intensity of fog at
Travis AFB has been a long standing forecasting problem.
Three operationally significant threshold values of cloud
ceiling (feet) and visibility (miles) are of interest:

    a. 100/1/4 - Cat II ILS minimums
    b. 200/1/2 - C141,KC-135 and Contract Carrier minimums
    c. 300/3/4 - C-5 minimums

The biggest concern is with "now plus six-hour" forecasts of
the above thresholds. This report provides a tool to help
personnel make an operational decision.

The Simulated Mission Success Indicator

The SMSI was prepared for the months of November through
February (the four months with the greatest frequency of
fog). They are based on the hours used in Part D of the
Revised Uniform Summary of Surface Weather Observations
(RUSSWO). Appendix A of this report explains the SMSI
printout.

The best way to describe a procedure is to present a
realistic example: the rest of this report presents such an
example.

Example SMSI Application

    a. The Simulated Problem

A C-141 is scheduled to depart station A at 0900Z in
December with arrival scheduled at Travis AFB at 1500Z

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(0100LST and 0700LST respectively at Travis AFB). Operations personnel must decide if the flight should be dispatched. The SMSI is a tool which will help them make the decision depending on what "risk" or "non-risk" they are willing to accept.

b. The SMSI

First review Appendix A to this report. Note that operations personnel decide, by reviewing columns A, B, C, and D with particular emphasis on columns A and C, what probability of success they can expect if they decide to go and what probability of failure they will accept under the same decision. Then and only then should they proceed along the same row to the Critical Probability (CP) column. For example, suppose one will accept the 0.799 probability of success and a 0.061 probability of failure if he executes the mission (Table 1). Proceeding to the CP column he finds the value 0.500. Now the operator calls the weather station and obtains the probability forecast that Travis will be >200/1/2 at 0700LST (1500Z). If the probability forecast is greater than the CP, the decision would be to dispatch the aircraft.

c. The Probability Forecast

This type of forecast can be obtained from the conditional tables of USAFETAC Report 8088A; the forecaster can make his own probability forecast; or the AFGWC could provide a probability forecast. For example, using the stratified conditional climatology as a forecast, assume the 0900Z wind is calm, the temperature/dewpoint spread is 1, the ceiling is 300 ft, and the visibility is 1 mile. Table 2 is extracted from the stratified CC tables for ceilings at 0900Z at Travis AFB. With the stratified conditions mentioned above, the probability of category A (0-<200ft) 6 hours later is 0.30 or the probability of > 200 ft is 0.70. Table 3 provides the probability for visibility with the same stratified conditions. Thus the probability of category J (0-<1/2 mile) is 0.20 or the probability of > 1/2 mile is 0.80. An estimate of the combined probability is given by an equation suggested by Boehm [2]:

$$JP = 0.7 \ (Pc) \ (Pv) + 0.3 \ (min \ value \ Pc \ or \ Pv) \qquad (1)$$

where JP is the joint probability, Pc is the ceiling probability, and Pv is the visibility probability. Substituting the probabilities from above into equation 1:

$$JP = 0.7 \ (0.70) \ (0.80) + 0.3 \ (0.70) \qquad (2)$$
$$= 0.602$$

the probability that Travis AFB is $\geq$ 200/1/2 at 0700LST in December.

Conclusion

In this example, the operations personnel would decide to execute the mission because the probability forecast that Travis will be $\geq$ 200 1/2 is greater than the critical probability. We have used the stratified conditional climatology tables for example purpose only. We strongly suggest that a forecaster at the station should make the probability forecast or AFGWC should provide the necessary probability forecast.

References

[1] Young, Murray J., "Wind Direction/Dew Point Stratified
     Conditional Climatology Tables for Travis AFB,
     California (745160)," USAFETAC Report 8088A, Sep
     1976, 4pp.

[2] Boehm, Albert R., "Transnormalized Regression
     Probability," Air Weather Service Technical Report
     75-259 (AWS-TR-75-259), December 1976, 48pp. (to be
     published about 1 May 77)

Table 1. Simulated Mission Success Indicators for Travis AFB

USAF ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER (USAFETAC) SIMULATED MISSION SUCCESS INDICATORS- 30-MAR-77

STATION : TRAVIS AFB CAL   MONTH : DEC   CLIM PROB : 0.831

CATEGORY : >2006.50   START TIME : 01L   FORECAST TIME LENGTH = 6 HRS ** VALID AT : 07L

CRITICAL PROBABILITY	MISSION EXEC WITH SUCCESS	MISSION NOT EXEC WOULD HAVE SUCCEEDED	MISSION EXEC DID NOT SUCCEED	MISSION NOT EXEC AND WOULD NOT HAVE SUCCEEDED
0.050	0.831	0.000	0.144	0.025
0.100	0.830	0.001	0.131	0.038
0.150	0.828	0.003	0.120	0.049
0.200	0.826	0.005	0.110	0.059
0.250	0.823	0.008	0.101	0.068
0.300	0.820	0.011	0.092	0.077
0.350	0.816	0.015	0.084	0.085
0.400	0.811	0.020	0.076	0.093
0.450	0.806	0.025	0.069	0.100
0.500	0.799	0.032	0.061	0.108
0.550	0.791	0.040	0.054	0.115
0.600	0.781	0.050	0.047	0.122
0.650	0.770	0.061	0.040	0.129
0.700	0.756	0.075	0.034	0.135
0.750	0.740	0.091	0.027	0.142
0.800	0.718	0.113	0.021	0.148
0.850	0.690	0.141	0.015	0.154
0.900	0.650	0.181	0.010	0.159
0.950	0.583	0.248	0.004	0.165

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Table 2. WIND/DEW POINT STRATIFIED CONDITIONAL CLIMATOLOGY TABLES

PREPARED
AUG 1976

FOR

745160 - TRAVIS AFB, CA

BY

UNITED STATES AIR FORCE
ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER (ETAC)

SEASON: WINTER

CEILING AND VISIBILITY CATEGORIES ARE AS FOLLOWS:

A   0 - < 200 FT   J   0 - < 1/2 MI

B   200 - < 500 FT   K   1/2 - < 1 MI

C   500 - < 1000 FT   L   1 - < 2 MI

D   1000 - < 3000 FT   M   2 - < 3 MI

E   300 - <12000 FT   N   3 - < 6 MI

F   10000 - NO CIG   O   6 - NO VIS

ALL TEMPERATURE DEW-POINT SPREAD VALUES ARE (F)

Table 2a. Wind/Dew Point Stratified Conditional Climatology Tables for Ceiling at Travis AFB

STATION: 745160 - TRAVIS AFB, CA   SEASON: WINTER
3-6 HOUR CLIMATIC CONDITIONAL PROBABILITIES (ROUNDED TO NEAREST TENS OF PERCENT) AND THE MEDIAN CEILING (FEET)

WIND DIRECTION: (0-3 KTS)   HOUR: 9 (GMT)

6HR FORECAST

	SPREAD	0 MED	SPREAD	1 MED	SPREAD	2 MED	SPREAD	3 MED
	ABCDEF		ABCDEF		ABCDEF		ABCDEF	
0F	622012	178	421012	335	311013	583	312013	766
100F	521012	252	420013	389	311013	833	311013	928
200F	420111	304	331112	427	221112	645	221212	863
300F	331112	350	331112	451	221112	722	221213	916
400F	431112	355	331112	455	221212	812	221212	958
500F	411212	384	321112	625	221112	937	221212	1399
600F	411212	384	321112	687	221112	944	221113	1428
900F	410212	392	321112	777	221122	1285	221222	1750
1000F	331112	466	231112	833	131112	1714	121113	2384
1500F	331112	476	231112	944	121113	2076	121113	2714
2000F	331112	487	131112	1153	121113	2230	121124	3000
2500F	331112	487	131122	1166	121124	2333	121124	3466
3000F	401122	928	211222	2176	111223	2699	112223	3368
5000F	301122	1363	111222	2750	111223	3954	111223	5434
10000F	312122	972	211133	5074	111134	7749	100135	9249
NO CIG	200016	11935	101018	13421	100018	20000	000019	20000

Table 2b. Wind/Dew Point Stratified Conditional Climatology Tables for Visibility at Travis AFB

STATION: 745160 - TRAVIS AFB, CA   SEASON: WINTER
3-6 HOUR CLIMATIC CONDITIONAL PROBABILITIES (ROUNDED TO NEAREST TENS OF PERCENT) AND THE MEDIAN VISIBILITY (MILES)

WIND DIRECTION: (0-3 KTS)   HOUR: 9 (GMT)

6HR FORECAST

	SPREAD	0 MED	SPREAD	1 MED	SPREAD	2 MED	SPREAD	3 MED
	JKLMNO		JKLMNO		JKLMNO		JKLMNO	
0M	611011	0.4	511011	0.5	411012	0.8	412022	1.2
1/16M	611011	0.4	511012	0.6	411022	1.1	312022	1.5
1/8M	611011	0.5	421012	0.8	321022	1.1	312022	1.5
1/4M	521011	0.5	421012	0.8	312022	1.2	312022	1.7
1/2M	421012	0.7	322012	1.0	312022	1.5	312022	1.6
3/4M	421012	0.8	321112	1.2	212122	1.6	212122	1.6
1M	331012	0.9	222112	1.5	024122	1.8	024122	1.9
1 1/2M	321022	0.9	221022	1.6	014222	1.9	014222	2.0
2M	421012	2.7	321022	1.1	222022	1.6	222222	2.1
3M	321013	1.4	212123	2.7	111233	3.3	111233	3.6
4M	312013	1.5	211123	3.0	111133	3.7	111233	4.1
5M	312013	1.5	212124	3.4	112124	4.3	111134	4.7
6M	411004	1.4	221024	3.9	112124	4.5	111124	5.0
7M	411004	1.6	211025	5.1	211124	5.8	111124	6.5
10M	200007	8.8	100009	15.0	000009	15.0	000009	15.0
15M	200009	8.8	100009	15.0	000009	15.0	030009	15.0

SMSI PRINTOUT EXPLANATION

USAFETAC SMSI's		
STATION: (1)	MONTH: (2)	CLIM PROB: (6)
CATEGORY: (3)	START TIME: (4)	FCST LENGTH __ VALID AT __ Z (5)

EXPLANATION OF SMSI TABLES

(1) Stations for which MSI is being provided

(2) Month being considered (all data for April)

(3) Weather category being forecast: considers probability that weather conditions will be greater than or equal to category.

(4) Start time of forecast

(5) Forecast time length is multiple of 6 hours and corresponding valid time as related to start time (4).

(6) The climatological probability that the weather will be greater than or equal to category (3) at valid time of forecast(5).

DECISION

MISSION EXEC WITH SUCCESS A	MISSION NOT EXECUTED. WOULD HAVE SUCCEEDED B
MISSION EXECUTED DID NOT SUCCEED C	MISSION NOT EXECUTED AND WOULD NOT HAVE SUCCEEDED D

RESULT

Table portion of SMSI output.

CRITICAL PROBABILITY	A	B	C	D
0.05	0.801	0.001	0.164	0.034

Values listed under columns labeled A, B, C and D correspond to the information contained within the decision matrix above. The selection of a critical probability will determine the degree of mission success based upon forecasting capability and the climatological probability of the weather being greater than or equal to the category. The critical probability should be selected as a threshold where a go decision is made whenever the weather category probability is equal to or greater than the threshold. To determine a threshold for a specified month, location and forecast time, the first and third columns should be weighed by the decisionmaker. Selection of a threshold will be dependent upon whether or not a person is "risk or "non-risk" oriented.